interesting. Orthogenesis is a progressive variation or biased heredity in a given direction in successive generations. It is not a constant process, but one which is active in a certain characteristic in a particular species for a limited time, while most other characteristics are untouched by it. Let us call one of these lines of orthogenetic activity an "orthogenetic run" after the analogy of the "run" on a special line of merchandise which merchants occasionally experience. In such an orthogenetic run the individual steps are often not affected by selection up to a certain point, or only to so slight a degree as to be relatively negligible. But a "run" may eventually reach the threshold of a decisive selective value. Natural selection will then stop the course of the run. The "run" may be eradicated from the species, or when it is too persistent to be eradicated, then the species will be exterminated, as I imagine has taken place in the Irish elk and in the excessively spiny species with which many extinct mollusc genera have culminated.

But the result of such continued checking of inimical runs and the tolerance of other neutral or beneficial runs is to determine to some degree the kinds of "runs" that will arise in the future. Thus "runs" dealing with distribution of hair and hair modifications in great variety have been tolerated or encouraged, so that runs of this kind became commoner. On the other hand, runs affecting the chemical constitution of the red blood corpuscle once it had reached the vertebrate standard have been so promptly checked that variation in this characteristic has been checked and a high degree of conservatism resulted.

The analysis of the experiments given has a further value in its bearing on the question of the possible selective value of minute variations. Indisputably there has been too general a faith in widespread selective values in the past. At present, however, we can see evidences of an unjustifiably extreme reaction. In the consideration of selective values, critics have been wont to compare two adjacent classes of the frequency polygon and to descant on the improbability of a selective value. A safer viewpoint is to consider the chances of two classes not immediately adjacent. If a selective value is found between some two classes, we may be fairly sure that the selective value will not end abruptly, but become less step by step in passing from one class to the other. It is absurd to expect a high survival rate in one class and a low one in the next. In almost all cases we must expect the survival rate to gradually increase or diminish from class to class. This is the verdict of the experiments. It is idle to talk about the impossibility of selective value of minute differences, when it is possible to measure and analyze them.

The object of this paper has been to develop the method of analysis of natural selection by the construction of survival curves, in order, first, to extract more meaning from the experiments already performed, but second, and especially to encourage further selection experiments by making it possible to obtain more significance from them. Its publication has been delayed four years that the author might add some applications of the method. Occupation upon another line of research makes its publication necessary now without such results in the hope that they will be supplied by others.

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Special Articles

Botanical Evidence of the Age of Certain Ox-bow Lakes

In the southeasternmost county of Arkansas, near the Mississippi River, there is a crescent-shaped ox-bow lake about 15 miles long, of a type frequent in the flood-plains of large sluggish rivers, known as Lake Chicot. Lake Village, the county-seat of Chicot County, is located on the side farthest from the river, and the railroad from that point to Luna Landing on the Mississippi skirts its northern bank for a few miles. At present the shores of this lake are mostly pastured, but at

the water's edge on both sides, where it is visible from the railroad at least, it is bordered by a thin fringe of small cypress trees (*Taxodium distichum*).

Observations on this tree in all the southeastern states and in fourteen different years have led me to believe that it is rarely or never found on the banks of rivers or other bodies of water which have an average seasonal fluctuation of more than ten or twelve feet. Its trunk usually emerges from the ground just about low-water mark, and its enlarged base and "knees" are generally believed to reach up approximately to the average level of high water;[1] the figures just mentioned being about the maximum height recorded for these excrescences. Now the Mississippi River in the latitude of Lake Chicot has a seasonal fluctuation of about forty feet, and the cypress is absent from its immediate banks, though visible from the river in some places where it grows in nearby sloughs not directly connected with the main channel.

Presumably, therefore, when the waters of the Mississippi flowed through what is now Lake Chicot the cypresses which fringe the lake to-day did not exist. When the lake was cut off from the river, in the manner described in all treatises on potamology, its seasonal fluctuations were of course at once greatly reduced, and conditions then became suitable for the growth of the cypress on its banks. Consequently if one could determine the age of the oldest of these trees, by counting the annual rings or otherwise, that would give a minimum estimate of the age of the lake. As I have seen this lake only from the train, I have no data about the annual rings of its cypresses, but there is some evidence of another sort that they are comparatively young for that species.

Young cypress trees, of either species, are spindle-shaped in outline, much like the typical conventional conifers of the cooler parts of the northern hemisphere, while mature individuals are always more or less flat-topped, a character by which they can often be distinguished from other trees at a distance of several miles.[2] At just what age *Taxodium distichum* reaches its maximum height and begins to develop a flat top has not been determined, but very likely it is between 100 and 300 years.[3] The cypresses of Lake Chicot are mainly spindle-shaped, and perhaps date back only to the eighteenth century.

This supposition could easily be tested by a visit to the place in question with suitable tools. At the same time the cypresses bordering other ox-bow lakes along the Mississippi, especially those lakes whose age is a matter of historical record, should be examined from the same point of view. Additional evidence might be gathered from other swamp trees, especially the tupelo gum, *Nyssa uniflora,* which is common in sloughs and rare or absent on river-banks, bearing about the same relation to seasonal fluctuations of water that *Taxodium distichum* does. But the cypress is best for this purpose, on account of its longevity.

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[1] See *Bull. Torrey Bot. Club,* 32: p. 108, 1905.

[2] Hilgard ("Soils," 507–508, 1906), Cowles ("Ecology," 734, 1911), and some other writers have noted that the cypress when growing in uplands, such as parks, is spindle-shaped (see illustration in *Rep. Mo. Bot. Gard.,* 15: pl. 16, 1904), and have tried to correlate shape with habitat. C. S. Chapman (U. S. Bureau of Forestry, Bull. 56: 41–42, 1906) ascribes the flat top of cypress in Berkeley County, South Carolina, to the disease known as "peckiness," while Cowles, in the work cited, considers the flat-topped trees dwarfed on account of "the imperfect absorption which is characteristic of swamps." But age alone would seem to be a sufficient explanation of the difference in shape, since there is no doubt that all the younger trees, whether in their native swamps or in parks, are spindle-shaped, and the largest individuals known are flat-topped.

[3] The species has been known to civilized man only about 300 years, and presumably none of the existing cultivated specimens are old enough yet to have lost their juvenile form.

ON COMPARING AMMONIFYING COEFFICIENTS OF DIFFERENT SOILS

IN a recent publication[1] Professor W. G. Sackett gives some interesting results of a